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A New Role for Government**

Mary Tripsas, Stephan Schrader and Maurizio Sobrero
MIT Sloan School of Management
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Abstract

The traditional role attributed to government in collaborative R&D has been one of funding. This paper explores a new role for government in facilitating collaborative R&D, one of discouraging opportunistic behavior. Given the nature of R&D, concerns about opportunistic behavior can serve as a major barrier to the formation and effective operation of collaborative R&D. Using a transaction cost framework, we identify mechanisms by which the government can help to discourage such behavior. Specifically, we examine the Italian Società di Ricerca program where the government appears to be performing this role.

Our findings demonstrate that, not only can government help to control opportunistic behavior in collaborative R&D, but firms recognize and value that role. Overall, Italian firms participating in a Società di Ricerca valued government assistance in establishing long term relationships and facilitating networking as much as they valued funding. In addition, whether a firm had prior experience in collaborative R&D affected its valuation of government involvement. Firms with prior experience in collaborations placed less value on government frameworks for cooperation implying that they had learned to manage some ex-ante considerations on their own. Ex-post opportunism, however, was still a concern and thus experienced firms continued to value government's contributions in this area.

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1. Introduction

The increasing popularity of various forms of collaborative R&D throughout the U.S., Japan, and Western Europe has raised many questions about what role, if any, government should play in facilitating such efforts. Traditionally, the primary role attributed to government has been funding [12]. By providing a pool of funds for collaborative projects, governments encourage firms to work together in a specified technological area. Examples of such subsidies in Japan are well known. The Japanese government began sponsoring collaborative research through Engineering Research Associations (ERA's) in the early 1960's, and they have become the major institutional mechanism used by firms to execute joint research. [34]. In fact, approximately 80% of the research loans made by the Japanese government are devoted to joint projects [54]. European governments have also joined together to sponsor collaborative research in a number of areas through programs such as ESPRIT (European Strategic Program for R&D in Information Technology), EUREKA (European Research Coordination Agency), and BRITE (Basic Research in Industrial Technologies for Europe).¹ Government funding of such programs is substantial, with a government budget of 750 million ECUs for the first 5 year phase of ESPRIT [51]. Finally, the U.S. government has recently joined the bandwagon, contributing major funding to Sematech, a collaboration of U.S. firms in the semiconductor industry. In each of these cases, government funding helped induce firms to participate in collaborative R&D.

The goal of this paper is to explore an additional role for government — one of facilitating collaborative R&D by decreasing the potential for opportunistic behavior among partners. Concerns about opportunistic behavior can serve as a major barrier to the formation and effective operation of collaborative R&D [19, 39, 46]. Firms are reluctant to commit resources to a joint project if they feel vulnerable. In many ways, the government is especially well suited to alleviate such concerns. Government can help to discourage opportunism through institutional mechanisms, such as defining the legal framework for cooperation, as well as through administrative mechanisms, such as membership in the governance body of a collaboration. In this paper, we examine the Italian Società di Ricerca (research consortia)

¹ Much has been written about these efforts. If interested in more details, we refer the reader to [51, 57].

program where the government appears to be performing both institutional and administrative functions. Other institutions such as industry associations or respected universities may be able to perform similar functions, however, in this paper we focus our discussion on government.

Our findings show that not only can the government help to discourage opportunistic behavior in collaborative R&D, but firms recognize and appreciate that role. Overall, Italian firms participating in a Società di Ricerca valued government actions such as helping to establish long term relationships and facilitating networking no differently from how they valued funding. In addition, there is evidence that firms learn through experience to better manage some aspects of collaboration, but not others. Firms with prior experience in collaborative R&D valued government assistance differently from those for whom the Società was their first collaborative experience. Firms with prior experience placed significantly less value on government's institutional role of establishing a framework for cooperation than firms without prior experience did. Presumably these firms had learned to manage the initial set-up of a collaboration and felt less need for government guidance. They did not, however, learn to manage ex-post opportunistic behavior on their own, and still valued government's administrative role in controlling opportunism. In fact, these firms valued government's administrative role more highly, relative to funding, than firms with no prior experience did. It would appear that a comparison with the other collaborations in which they participate, made these firms more appreciative of the role of the government in controlling ex-post opportunism.

The paper is organized as follows. We first review the incentives of individual firms to participate in collaborative R&D irrespective of any government role (Section 2). Despite these incentives, socially suboptimal levels of collaborative R&D may persist due to the potential for opportunistic behavior on the part of members. From a transaction cost perspective, we examine some of the problems encountered in setting up and running collaborative R&D projects (Section 3). We then explore how the government can help alleviate these costs (Section 4). In support of the theory, we examine the Italian Società di Ricerca program (Section 5). Finally, through a set of in-depth interviews with Società di Ricerca participants, supplemented by empirical evidence from a written survey of 39 firms participating in the program, we explore how firms perceive the role of

the government in establishing and operating research collaborations (Section 6).

2. Firm Incentives for Collaborative R&D

Firms have a number of alternative mechanisms for tapping the research capabilities of other firms, including acquisition, licensing, outsourcing, and collaborative R&D.² Collaborative R&D appears to be an increasingly popular choice. The percentage of collaborations that involve some form of R&D has grown substantially in the last decade. In Hladik's [28] sample of 420 international joint ventures, less than 10% of joint ventures formed from 1974 to 1977 involved R&D, whereas by 1982, 20% did. R&D executives also consider cooperative research to be increasing in importance. Link and Bauer [35] report survey data from over 100 U.S. R&D vice presidents. The mean rating for the importance of cooperative research rose from 2.5 in 1982 to 3.7 in 1985 (on a 5 point Likert scale, 5=very important, 1= not important at all). In addition the U.S. government officially sanctioned precompetitive cooperative R&D with the passage of the NCRA (National Cooperative Research Act) in 1984. This act alleviated some of the antitrust concerns of U.S. firms contemplating cooperative R&D by eliminating treble damages if firms filed with the government before forming a collaboration.³

There are many potential reasons for firms to participate in collaborative R&D, and there is no general agreement as to which are the most important. Empirical surveys of firms participating in such collaborations as well as case studies and game theoretic models substantiate the following incentives:⁴

- Economies of scale in research
- Economies of scope in research
- Ability to finance costly projects

² We will not distinguish between R&D Consortia, Research Joint Ventures and other forms for organizing collaborative R&D. For our purposes, mutual commitment of resources to a research project is sufficient, regardless of legal structure. Porter and Fuller [46] treat all types of coalitions as a class of transactions, pointing out that there is "no simple relationship between the legal form of coalitions and the purposes they are designed to achieve." (p.316)

³ It is unclear that the NCRA has actually encouraged more firms to engage in cooperative R&D. The number of firms actually filing has not been particularly large[31] and R&D executives did not consider the act an important influence on their decisions to collaborate [35].

⁴This section summarizes rationale for collaborative R&D discussed in the following references: [1, 7, 15, 16, 23, 25, 27, 30, 31, 35, 36, 38, 42, 43, 48, 50, 53, 56]

- Avoidance of unnecessary duplication of research ⁵
- Risk management
- Access to know-how network
- Obtaining a window on related technologies
- Exploitation of partners' complementary positions
- Internalizing the externalities created by research spillovers

Despite these benefits, firms may still invest socially suboptimal amounts in collaborative R&D. When firms are able to increase the efficiency of their R&D efforts through collaborating, society as well as the firms benefit. Unfortunately, fear of opportunistic behavior may inhibit firms from engaging in such socially beneficial collaborative R&D. Firms may, justifiably, feel vulnerable to exploitation and therefore be reluctant to commit resources to collaborative projects.

We will focus on this reason for underinvestment in collaborative R&D and how government policy can address it.⁶ Using a transaction cost framework, we will examine specifically how the potential for opportunism increases the costs of engaging in a collaboration. As Porter and Fuller [46, p.340] point out “the transaction costs of negotiating and managing coalitions are a significant barrier to coalition formation.”

3. The Transaction Costs of Collaborative R&D

3.1 Transaction Costs and the Nature of R&D

Transaction cost theory [58, 59] proposes that efficiency in executing transactions drives the organization of economic institutions. Efficiency is achieved by minimizing the sum of both production and transaction costs. Production costs include familiar items associated with the construction of a product, such as raw materials and labor. Transaction costs are less concrete. They include, for instance, the legal and management fees associated with negotiating a contract, the costs of monitoring the contract, and the cost of enforcing the contract. Whereas production costs may be lower if a firm

⁵ In some cases duplication of research efforts may be beneficial in that, if different organizations take different approaches to solving a problem, there is a higher likelihood that one will succeed. Focusing on one approach, especially in the early stages of a technology's development, may actually inhibit innovation [40].

⁶ Other reasons noted for underinvestment in collaborative R&D include imperfect appropriability [15] and risk aversion.

contracts out a certain piece of work, the transaction costs associated with executing that contract may be high. If the transaction costs outweigh the savings in production costs, the firm will be better off internalizing the work.

Since transaction costs are often difficult to observe, the theory identifies conditions under which they are likely to be high. Given the presence of opportunistic behavior and bounded rationality, transactions costs are determined by four transaction characteristics: asset specificity, uncertainty, information asymmetry and transaction frequency. The nature of R&D is such that the transaction costs of establishing and running an R&D collaboration are likely to be quite high. We now step systematically through the transaction characteristics associated with collaborative R&D to understand why this may be the case.

Collaborative R&D often involves high levels of asset specificity. When a firm performs part of a research project, the knowledge it gains may be useless unless combined with the work from other firms. In the biotechnology industry as firms move from generic research to product development, "much more of the know-how generated is idiosyncratic to the product and firm-specific" [44, p.247]. Thus, if products are developed jointly, the knowledge only has value in the context of this joint development.

The level of uncertainty in any R&D project, including collaborative R&D, is high. Nelson and Winter [41] criticize traditional economic views of innovation for focusing on shifts in the production function and ignoring the uncertainty surrounding the innovation process. They argue that "innovation involves uncertainty in an essential way" (p.47). The output of the research process is uncertain in a number of aspects: 1) The absolute level of output is difficult to predict. One may anticipate a threefold increase in performance and instead obtain only a twofold increase or perhaps even a fourfold increase. 2) The timing of results is unclear. Research projects do not provide a steady stream of results, and it is difficult to predict findings ahead of time. 3) The specific area in which results will be applicable is uncertain. For example, a research project meant to solve one problem may easily end up solving another [45].

Information asymmetries are also common in collaborative R&D projects. In order to protect proprietary interests, firms often divide projects into distinct modules to be performed separately by each firm. In the Japanese VLSI project, for instance, company labs performed sensitive research, as opposed to the central cooperative lab, in order to protect proprietary

information [20, 28]. By organizing projects in this manner, however, each firm has access to a different set of information about how the project is progressing. It is therefore very difficult for them to monitor each other's progress.

Finally, the mere frequency of interactions in collaborative R&D may be high. If two firms' research modules are highly interdependent, then frequent communication and costly coordination may be necessary.

Since collaborative R&D typically involves high levels of asset specificity, uncertainty, information asymmetries and frequency of interaction one would expect high transaction costs associated with collaborative R&D. We will now examine in more detail the specific transaction costs which arise.

3.2 Ex-ante Transaction Costs of Collaborative R&D

In structuring collaborative R&D, potential partners must reach agreement over a wide variety of issues before finally deciding to work together. Given the nature of R&D discussed above, the costs associated with reaching agreement on these issues can be significant. In Boeing's joint development of the 7J7 with a group of Japanese firms, Moxon et. al. [39, p.273] point out, "No longer able to rely on 'the Boeing way' as a means of dispute resolution, the two firms have had to develop a much more detailed set of plans for handling the upcoming venture... working groups spent more than a year developing concrete statements about various parts of the project and defining work shares."

In addition, the difficulties in negotiating an acceptable agreement among partners increase rapidly with the number of participants. With two firms there is one relationship to worry about; with three firms there are three relationships, with four firms, six relationships and so on. Getting a collaboration of many firms to agree can therefore be extremely difficult.⁷

We have identified 4 areas of contention which firms must attempt to resolve in ex-ante negotiations when forming a research collaboration:

- 1) Control of ownership, 2) Distribution of research contributions and results,
- 3) Goals of the collaboration, and 4) Protection of proprietary technology.

⁷ Brockoff [7, p.519] argues "that firms should be able to find arrangements to deal efficiently with cooperation regardless of the numbers of partners involved." He provides empirical evidence that partially support this proposition. However, the argument requires that the firms negotiate with the cooperative entity and not directly with each other.

3.2.1 Control of Ownership

Often, disputes emerge over who will have control in a collaborative venture [29,39]. Generally, in a two-party relationship, each player wants the majority for fear that if the other player has control, it will exploit that position. In multiparty consortia, control is still a key issue, with increased complexity given the larger number of parties involved. Smaller firms may feel extremely vulnerable when dealing with larger firms. Doz, [19, p.323] in an analysis of technology partnerships describes “an almost visceral fear on the part of managers and owners of the smaller firm, of the bigger firm taking detrimental action that the small firm cannot resist and that could put its future in jeopardy.” Concerns about subgroup coalitions may also exist. Time and legal fees spent negotiating ownership can therefore be substantial, and, in some cases, no agreement is reached and the collaboration abandoned. Hladik [29] describes a potential product development collaboration between Ford and Fiat which would have given each firm access to key technologies, as well as providing complementary market coverage. Unfortunately, the two firms reached a deadlock in negotiations over ownership control, and the deal was canceled.

3.2.2 Distribution of Contributions and Results

In any collaboration, rules for how much each firm should contribute and for how the profits are to be shared are difficult to establish. Firms may each feel that they contributed more than the other, or that they contributed the key personnel [6]. Agreement on the distribution and ownership of research results suffers from similar problems and is often a matter of contention in collaborative R&D, especially if the firms are potential competitors in downstream product markets [44]. The uncertainty and information asymmetries associated with R&D make it difficult for firms to precisely specify rules ex-ante. It is unclear how much of a “contribution” will be needed in order to accomplish a given result. It is also unclear as to when that result has been achieved. Guidelines for who controls the day-to-day management of various pieces of the project take on increasing importance since allocations are likely to change throughout the course of the project. The ex-ante transaction costs associated with negotiating rules for contributing and sharing can therefore be substantial.

3.2.3 Goals of the Collaboration

In order for a collaboration to succeed, partners must agree on the goals of the venture. Doz [19, p.319] calls this consensus “convergence of purpose,” noting the importance of common operational goals. Moxon et al. [39] refer to the importance of a common “strategic direction,” in other words, agreement on the product-market segment targeted by the venture. The goals of an R&D collaboration also include definition of the technological scope and identification of criteria for prioritization of research projects.

Reaching agreement on such factors is very difficult given the transaction characteristics discussed above. The uncertainty surrounding most R&D complicates each of these decisions. For instance, firms will find it difficult to specify the scope of a collaboration or a target product-market segment a priori since subsequent research results may shift priorities [44]. Information asymmetries also make agreement difficult. Given the knowledge available to them, each firm may have a different view as to the important areas to pursue. Reaching agreement may involve sharing of information which the firms consider proprietary. These difficulties result in high transaction costs associated with spelling out goals ex-ante.

3.2.4 Protection of Proprietary Technology

The desire of potential partners to protect proprietary technology can be a major obstacle to collaboration [39]. Firms must attempt to negotiate a governance structure which allows projects to be performed efficiently, yet without unintentionally sharing proprietary information. Many times, as mentioned earlier, firms will conduct research independently in their own labs in order to lessen the risk of losing intellectual property. In this case, firms must determine a logical split of the workload, forecasting interdependencies early on when there is high uncertainty about how different parts of the project will progress. This process can be lengthy, and often the firms have to renegotiate the workload at a later point in time.

3.3 Ex-post Transaction Costs of Collaborative R&D

3.3.1 Renegotiation

Since R&D is highly uncertain, much of the ex-ante contracting which takes place is destined to be incomplete. As a result, firms often agree to decide matters at a later date, once the collaboration is underway [19, 44]. Such renegotiation can be costly and thus result in high ex-post transaction

costs. In the biotechnology industry, disputes over renegotiated items often result in costly legal fees for the firms involved [44]. Even if the terms of a collaboration are well-specified, the cost of monitoring and enforcing it can be high.

3.3.2 Monitoring and Enforcement

Monitoring progress of a collaborative research project is difficult for at least three reasons. First, information asymmetries associated with distributed research make it difficult to accurately judge whether partners are abiding by the collaborative agreement. Since the purpose of distributing research to different sites is to protect proprietary information, it is unlikely that firms will allow partners access to those facilities in order to monitor progress.

Second, the uncertainty of research results accentuates difficulties evaluating a partner's contributions. Firms may attempt to monitor research results or output as a substitute for visiting facilities. Since, with R&D, no simple relationship between input and output exists, however, information about results will give a firm little real data on how hard the partner is working. A direct evaluation of effort would be a better measure, but effort is very difficult to gauge [19]. Consequently, several private ordering mechanisms normally used for addressing problems of opportunistic behavior do not work in such a situation. For example, the ex-ante coupling of opportunistic behavior with ex-post sanctions – such as posting a bond that is lost if a player behaves opportunistically, i.e. [24, 49] – is not a feasible alternative if it cannot be measured unambiguously ex-post whether players did fulfill their obligations. In other words, if performance cannot be gauged, as is often the case in R&D, players do not have the possibility to accept binding commitments.

Third, as information, the results of R&D have some public good characteristics. Information can be transferred to other parties without the transferee losing the information [9]. It is therefore difficult for a firm to monitor whether proprietary R&D results have leaked out or to determine how they might have leaked. Once information has leaked, controlling its usage is nearly impossible [3]. Agreements to keep certain technologies private are therefore difficult to monitor and enforce, and once they are violated, damage control is difficult.

The expectation that one's partner in an R&D collaboration will act opportunistically may well lead to a classic prisoner's dilemma where despite the fact that two firms would be better off by jointly cooperating, both firms individually have the incentive to defect. For instance, we can think of cooperating as sending a high caliber researcher to the consortium and defecting as sending a poor performer. Each firm may have the incentive to defect and send a poor performer regardless of what the other firm did. If firm X sends a high caliber performer, firm Y could conceivably reap the benefits of the research without having to contribute a high caliber researcher of its own. It would therefore have an incentive to defect and send a poor performer. Likewise, if firm X sends its low caliber performer, then firm Y would also prefer to send its low caliber performer rather than subsidize firm X's research by sending a top performer. Consequently, a "defect-defect" outcome where both firms send poor performers is likely. Given this incentive to defect, enforcing an agreement to cooperate may be difficult.

4. A Governmental Role in Controlling Opportunism

We have discussed the reasons why setting up and running collaborative R&D can lead to high transaction costs. In this section we explore several measures available to government that may help to discourage opportunistic behavior and thereby reduce transaction costs. We distinguish between institutional and administrative mechanisms.

Institutional mechanisms are those activities by which government helps to establish a framework for cooperative action through, for example, changes in the legal system. By shifting aspects of the institutional environment such as property rights, contract law, reputation effects or uncertainty, the comparative costs of different governance forms are altered [60]. Naturally, government is in an especially good position to fulfill such an institutional role. Government's activities in the context of its institutional role are primarily aimed at reducing ex-ante transaction costs of a collaborative venture.

Administrative mechanisms refer to government involvement in the actual workings of the cooperation, for example through membership in governance bodies. Through such involvement government may directly reduce ex-post transaction costs and, by doing so, indirectly reduce ex-ante costs.

4.1 Institutional Mechanisms: Decreasing Ex-ante Transaction Costs

The government can employ several mechanisms to decrease the transaction costs associated with formation of a research collaboration. By defining an overall framework for cooperation up front, the government can limit the negotiation space thereby reducing the number of alternatives that need to be explored. This framework can cover everything from details of the legal wording of the agreement to more general guidelines. Concerns over control can be alleviated if the government prespecifies how ownership of the collaboration will be distributed among partners, defining, for instance, rules for the allocation of shares in the case of a partnership or legal corporation. As long as they are reasonable, it may matter less in some sense what the specific rules are, than that they are there to provide guidance. The same principle holds for other issues. By providing a menu of options for the distribution of research results or the organization of projects, the government helps firms to more easily reach agreement.

One of the biggest reasons for ex-ante transaction costs is the fear of ex-post exploitation. To the extent that the government can help avoid such ex-post exploitation, it can significantly diminish the need for extensive contracting up front. If firms are less worried about ex-post exploitation, they will feel less need to anticipate and account for contingencies ex-ante.

4.2 Administrative Mechanisms: Decreasing Ex-post Transaction Costs

4.2.1 Monitoring

Axelrod [5, p.139] identifies "improve recognition abilities" as one means for promoting cooperation. By recognizing defection when it occurs and remembering which players defected and which cooperated, firms are better able to cooperate. The government can help improve a firm's ability to "recognize" and to "remember."

At an operational level, the collaboration could assign monitoring rights to the government. For instance, the government could appoint an auditor to examine ongoing research projects and ensure that firms are abiding by the intent of their original agreement. If research is being performed at multiple laboratories, this third-party auditor could visit each participant's site to evaluate progress. Though unable to eliminate uncertainty, the auditor can certainly help reduce some of the information

asymmetries discussed earlier. Such an individual would also facilitate information transfer among participants, if so desired.

Through its involvement over time, the government can help to serve as a memory which spans multiple projects. Knowledge of the level of cooperation on prior projects can be made available to firms other than just the project participants. This type of tracking can increase peer pressure to cooperate.

4.2.2 Threat of Reprisal

The government may have both explicit and implicit power to enforce agreements among firms. If government sponsors a collaboration, it will generally have representation on a board or advisory committee which oversees the operation of the collaboration. This board or committee may give the government the legal power to discipline firms which do not abide by the intent of the agreement.

Even without such explicit control, the government may have implicit power resulting from its ability to exclude firms from future collaborations if they appear uncooperative. For instance, Levy and Samuels [34] argue that Japanese firms feel obliged to cooperate with MITI so that they will continue to be included in future projects.

The ability of the government to enforce an agreement can help to avoid the prisoner's dilemma discussed above. In order to avoid the "defect-defect" outcome, both firms in a prisoner's dilemma could communicate and agree beforehand to cooperate. In order for such an agreement to succeed, however, each firm needs to both ignore its own incentive to defect and trust that the other firm will also do so. Like the monopolist in the classic Coase problem, the firms must find a way to commit to strategies that appear irrational. The question is how they can do so. The government can help by providing firms the necessary commitment device. The threat of reprisal, while not the equivalent of "burning the bridge behind the army," can be an effective commitment mechanism. As Levy and Samuels [34, p.128] point out, "In the absence of a state authority which rewards cooperation and occasionally punishes defection, research consortia are almost never established among competing firms."

4.2.3 Establishing Long-term Relationships

Another way to promote cooperation and avoid the problems of a prisoner's dilemma is through the establishment of long-term relationships. This approach works for two primary reasons. First, by extending the life span of the cooperation, the penalty for defecting is more severe. A firm that defects will face punishment over a long series of future relationships. Depending upon how much weight a firm places on future cash flows, the prospect of losing these future relationships may outweigh the temporary gain to be had by defecting [5, 49]. This result is demonstrated formally by game theorists through the folk theorems [22].

The second way in which a long-term relationship encourages cooperation is that it allows for enough interaction to establish a pattern of reciprocal, or tit-for-tat behavior. Such behavior, where a firm responds to every move by emulating the prior move of its opponent, can encourage cooperation [5]. For instance, the long-term stability of players in Japanese collaborations has made it easier to establish such self-policing behavior [34].

Clearly long-term relationships can help foster cooperation. How, then, can the government facilitate the establishment of such relationships? First, government involvement can help to establish continuity and stability in a collaboration, increasing the likelihood that firms will work together in the future. Firms therefore view their relationships as long term. They know the collaboration will be less likely to fall apart if one member decides to withdraw. Second, the government provides firms a chance to publicly demonstrate their willingness to cooperate. Buckley and Casson [8] suggest that by establishing a reputation for forbearance, through, for instance, a conspicuous public demonstration, a firm is more likely to form collaborative efforts. Third, as discussed earlier, by monitoring collaborations and providing the equivalent of an organizational memory of how firms have performed in previous collaborations, the government extends the time horizon of interactions, helping to encourage cooperation. Finally, the government can provide a forum for firms to establish long term networks. If firms can become acquainted with one another before collaborating, the chances their collaboration will succeed may increase. In addition, if firms feel they are part of a network, self-policing behavior among members of the network may be stronger.

We have thus seen that theoretically the government can play a significant role in controlling the potential for opportunistic behavior in collaborative R&D. We now examine how the Italian government plays this role in the Società di Ricerca program. We review how the program is structured as well as reporting the results of a survey of firms participating in the program.

5. Government's Role in the Italian Società di Ricerca

5.1 Methodology

In order to understand the Italian government's role in controlling opportunism, we conducted semi-structured interviews, in conjunction with a survey of firms participating in a Società di Ricerca (research consortium referred to as "Società" from now on⁸). We interviewed the director of the Società program and the general manager of each of eight Società in order to get an understanding of how the program operated. We then contacted several member firms of two Società and interviewed the individual responsible for the liaison. Interviews lasted from one to four hours.

Building on the information collected during our interviews, we developed a written survey for firms participating in a Società in order to understand how they viewed government's role. The survey was pre-tested and, in the fall of 1991, mailed/faxed to all 104 firms participating in a Società. For one Società, Tecnotessile, we received only 2 responses out of 24 partners. Approximately 2/3 of the partners had been members for less than one year and felt uncomfortable answering the survey given their lack of experience with the Società. We therefore excluded Tecnotessile from our analysis. We have no reason to believe that this biased our results.⁹ For the other 7 Società, from an overall sample of 80 partners, 39 questionnaire were returned, giving us a response rate of 49%.

5.2 Overview of the Società di Ricerca.

A Società di Ricerca is a government-sponsored research consortium comprising mostly private Italian firms, but also including private and public research centers and universities. Foreign entities are not allowed to join.

⁸ The plural of Società is also Società.

⁹ Turnover at the other Società has been minimal. Of the original founding partners, 90% are still members.

Each Società is incorporated, and members are all shareholders. A Società sponsors mostly applied research projects, with the goal of producing research results. It does not become involved in the product market.

Società di Ricerca were established by Italian Act 1089 in 1968. The general purpose of the act was:

“...speeding the progress and the development of the national industrial system and the adoption of more advanced techniques and technologies.”¹⁰

The government implemented the act through IMI, a government owned financial holding company, which serves as its agent in the context of the Società.¹¹ The sponsorship of Società was one of multiple mechanisms utilized to fulfill the objectives of the act.¹² The act identifies four broad goals, which serve as a guideline for the operations of a Società [14]:

1. To promote, perform and/or manage applied research projects autonomously or for third parties.
2. To participate in public research contracts.
3. To transfer technological knowledge to small firms.
4. To act as a link between industry and the national scientific community.

Members contribute fees to cover operating costs. In addition, projects sponsored by the Società are eligible to apply for government funding. There is no guarantee that funding will be forthcoming, although a majority of projects do receive government support. No official statistics exist for the

¹⁰ Legge 25 ottobre 1968, n° 1089, art. 4, comma 1.

¹¹ IMI is a publicly held financial institution whose controlling shareholder is the Ministry of Treasury. IMI initially specialized in medium and long term financing for industrial activities [11]. Over time, IMI has widened its scope to include direct participation in investment and merchant banking, as well as the provision and management of investment funds, mutual funds and life insurance products. IMI's role in the country's economic system has been shaped by law rather than by political appointments, thus sheltering it from current politics. Consequently, IMI acts here as a government agency abiding by well established legal mandates as opposed to the dictates of the current government. The decision to give IMI a prominent role in the management and control in the Società should then be considered within the policy framework established by Act 1089. Given its institutional role, IMI provides a link between government efforts to encourage R&D and the country's industrial system.

¹² IMI has two other mechanisms at its disposal for accomplishing this goal, directly *lending* funds at a subsidized rate to privately sponsored projects, and directly *granting* funds to privately sponsored projects. Projects sponsored by a Società are eligible to apply for these two types of funding. These two modes of supporting technological development are clearly financial and they have been studied in some depth.[2, 4, 21, 37, 55]. Few studies, however, have focused on the third mechanism, the formation of Società [17,47].

whole 20 year period of activity of the program, however a 1990 study [10, p.41] calculated that roughly \$60 million in loans and capital was allocated to the Società by the government from 1985 to 1989.

In order to establish a Società in a given field, a group of interested and eligible partners may initiate the process by submitting a proposal.

Alternatively, IMI may identify a set of partners with complementary interests and bring them together to submit a proposal. The proposals are approved by the Ministry of Treasury. Historically Società have been established in both ways, and no proposal has been rejected. As of July 1993, all eight Società started since 1971 were active and no proposals for the formation of new ones were pending.

Table 1 provides a brief overview of these eight Società and their progress. Overall, the program has had promising results, with 91 projects successfully completed over its life, resulting in 33 patent applications and 35 marketable products. In addition, the results of 54 projects are in the process of being further developed by either the participating firms or the Società.

--- insert table 1 about here ---

The Società themselves vary greatly. They cover both “high tech” industries such as pharmaceuticals and “lower tech” industries such as food. The number of partners ranges from a low of six in SAGO, the health management Società, to a high of twenty-four in Tecnotessile, the textiles Società. Some subset of these partners participate on each project. In addition, each partner can participate in multiple projects. The range of participation varies from a low of .5 projects per partner for Tecnotessile, where several partners are new and have yet to begin projects, to 8.1 projects per partner for Tecnomare.

Despite these differences, each Società is set up in a similar fashion, and governed by a similar set of rules. The establishment of these rules by the government helps establish a framework for cooperation and lowers the ex-ante transaction costs associated with forming a Società.

5.3 Società Institutional Mechanisms: Establishing a Framework for Cooperation

5.3.1 Predefine Share Distribution

When a new Società is founded, its shares are distributed among the participating firms according to the following rules:

- IMI holds a relative majority, usually about 30%. Since a 3/4 majority is needed to approve any major decision by the Società, this shareholding gives the government veto power.
- Remaining shares are divided equally among the members.
- Small firms can join together to form a "subconsortium" which owns the same share as each of the larger firms.
- If several firms belong to the same Holding Company, the sum of their shares must be less than IMI's share.
- After the Società has been established, the entrance of a new partner must be approved by a majority of the shareholders.

As an example, the share distribution of Tecnobiomedica, one of the Società, is presented in figure 1. IMI holds the relative majority (28%), with the other partners each holding the same share (6.5%). Furthermore, the partners include large independent firms (C.G.R, Elettronica), firms controlled by the major holding companies (Sorin(FIAT), Esaote Biomedica(IRI)) and small firms, represented by the consortium Corites.

By prespecifying equal distribution of ownership shares among potential partners, the government has eliminated disputes over control and thereby saved a great deal of negotiation time and effort. There is nothing to debate: if a firm is willing to accept an equal share, it can join, and if not, it shouldn't join. Eliminating the possibility of control by any individual firm allows each firm to accept a minority position without losing face. An independent third party, IMI, holds the relative majority. In addition, the problem of encouraging smaller firms to participate is solved by allowing them to join as a group. Smaller firms should feel less fear being dominated by larger firms in a collaboration since, in aggregate, they hold an equal share. Concerns over domination by a single holding company are also alleviated since no holding company is allowed to own a larger share than the government. In addition to rules for share distribution, the government provides guidelines for forming the collaboration.

--- Insert figure 1 about here ---

5.3.2 *Provide Guidelines for Organization Charter*

Two major documents are signed by the partners in order to form a Società: the *Statuto* and the *Patti Parasociali*. The *Statuto* is the formal incorporation document which establishes the Società as an organization which must abide by Italian corporate law. It establishes standard items such as the identity of the shareholders. The *Patti Parasociali* specifies agreements particular to this corporation. In this case, for instance, the distribution of research results is covered.

Whereas for a private research consortium the partners would have to negotiate the content of these two documents from scratch, in this case IMI provides clear guidance. Based on government guidelines, [14] IMI establishes norms for voting, controlling procedures and distribution of results. Specific wording is even suggested for major sections of the relevant documents. IMI thus defines the contractual content of the relations within the Società avoiding any need for extensive negotiation.

For example, results for all Società are distributed as follows: Once a project is completed, there is a period of time during which the Società has proprietary ownership of the results. During this period, partners active on the project have the exclusive right to use the results either as licensees or through other mechanisms. The length of this period varies depending upon factors such as the length of the project and its overall budget. By the end of the period the active partners must repay any outstanding government loans related to the project in order to obtain ownership of the results. If they do not do so, they lose any proprietary rights to the innovation and other partners in the Società can apply for licenses. Based on our interviews with the management of each Società, it appears that the active partners have always paid the loans back and kept ownership.

Although, in some ways, specifying such a charter limits the flexibility of the collaboration, by providing a predefined framework for cooperation, it eases the process of getting together, thereby decreasing ex-ante transaction costs.

5.3.3 *Reference Learning from Prior Società*

Perhaps one of the greatest assets IMI has to contribute to a Società is its experience with other Società. This experience gives the IMI an understanding of potential pitfalls to avoid, and helps to establish a culture of cooperation.¹³ It also decreases the uncertainty associated with formation of a Società since firms can look to the experience of existing Società. In order to facilitate the transfer of learning across Società, the same individual from IMI sits on the boards of multiple Società [47]. This individual is therefore able to provide a knowledgeable perspective on issues confronting each Società. Thus, the IMI's participation in each Società fosters learning both within a given Società as well as across Società.

5.4 *Società Administrative Mechanisms: Improving Ex-post Monitoring and Enforcement*

5.4.1 *Avoid Domination by a Single Firm or Coalition of Firms*

The Italian government helps ensure that no single firm or coalition of firms dominates the Società through two mechanisms. First, given the ownership and voting structure discussed above, IMI can basically veto any proposed action through its shares. This structure keeps any single firm or coalition of firms from unilaterally imposing its will on the Società. Second, the equal division of the remaining shares, regardless of the size of the firms involved, assures equal opportunities to both large and small firms. Smaller firms have the same voting rights as large firms and need not worry about being dominated.

5.4.2 *Ensure Management Follows Legal Charter*

In addition to using equity, IMI wields control through membership on the two supervisory boards of the Società: the *Consiglio di Amministrazione* and the *Collegio Sindacale*. The *Consiglio di Amministrazione* is the Board of Directors. For the Società, it includes only external members, and no operating management. The *Collegio Sindacale* is a 3 person board which reviews the actions of the Board of Directors and of the Società as a whole. It ensures that all of the activities of both are legal and consistent with the *Statuto*. If management, for instance, attempted to favor certain partners

¹³Watkins [57] raises a similar point regarding the "umbrella-consortia organizational design of Eureka and Esprit," pointing out that the history of previous collaborative research agreements "provide established norms and rules for cooperation."

over others, the *Collegio Sindacale* could intervene. IMI has the right to name one of the three members forming the *Collegio Sindacale* and some of the members of the Board of Directors. While it actively participates in long term strategic decisions through membership on the board, our interviews confirm that IMI does not otherwise participate in the Società's management. Figure 2 summarizes the relationship among the shareholders, *Collegio Sindacale*, Board of Directors and Management, highlighting IMI's participation in each.

--- insert figure 2 about here ---

5.4.3 Specify Independent Project Manager

Each project performed through a Società has an independent project manager who works for the Società. This individual supervises the execution of individual projects, coordinating the ongoing efforts of participating firms.¹⁴ Project managers are generally highly qualified individuals, and often hold advanced degrees. As a representative from one member firm commented:

"The Società provides us an important administrative service. Since every project requires coordination because of the different parties involved, the Società assigns a project manager. I speak with the manager of our project about three times a week, and he is very involved and very helpful."

The project manager helps to control opportunistic behavior in two ways. First, s/he is, in some sense, performing the role of a third party auditor described earlier. By following the detailed progress of the project through frequent conversations with each firm as well as site visits, the project manager is able to diminish the information asymmetries associated

¹⁴ The eight existing Società can be classified into two broad categories: 1) Coordinating Società (five), and 2) Operating Società (three). In a coordinating Società, research is distributed among the partners and performed with their own human resources and facilities. The Società performs predominantly an administrative function through the project manager. In the second case, an operating Società, a project manager is also provided. The Società, however, not only coordinates, but also executes the project using its own human resources and facilities. If partners have specific expertise, then they are also involved in projects as external contractors. The partner then receives its fee for the research as well as benefiting indirectly through its ownership interest in the Società. The role of the independent project manager is most critical in a Coordinating Società.

with distributed research. S/he can share each participant's current status with other participants. The Società project manager can visit a firm's research facilities without the firm worrying as much about leaking proprietary information to a competitor. As the general manager of one Società told us,

"The partners know that we will assure confidentiality on what we see during our visits to their research sites. They agree to work with the Società because they know that they do not run any risk of information leakage on other research they are performing."

Second, the project manager provides consistency and continuity across multiple projects, helping to decrease the perceived hazards of the collaboration. Firms can observe how the structure has worked in prior projects and feel more comfortable about their own project. In addition, learning may be more easily shared across projects.

5.4.4 Provide Long Term Perspective

As discussed above, long-term relationships are important in fostering trust among firms and avoiding a prisoner's dilemma. The government helps to establish a long-term perspective through a number of mechanisms. IMI's share ownership provides continuity in spite of potential changes in Società membership. In a private consortium, members would be more vulnerable to turnover. The comments of a representative from one member firm exemplify this concern:

"My firm participated in a private research consortium with eight other firms about ten years ago. The consortium fell apart, with three of the original nine firms going out of business. The rest of us are left paying the debt. With the Società, IMI's presence provides us some sense of stability."

In addition to providing continuity, IMI serves as an organizational memory which spans Società. Each firm builds a history of projects with IMI. By not cooperating, it risks its reputation not only within its Società, but with other Società and with IMI. Firms therefore do not view each project as an isolated relationship, but instead take a longer-term perspective.

Finally, through holding bimonthly meetings of the representatives from each firm in a Società, IMI provides a forum for exchanging ideas and establishing long-term personal relationships. This “sponsored” networking provides a way of finding project partners with whom a prior relationship exists. Firm representatives are not meeting for the first time when they consider working together, but instead, have established at least some basis for trust. As a representative from one firm stated,

“By meeting all together every two months, we are able to establish a higher level of trust and also be aware of what other firms are doing.”

When asked in the written survey whether the firm was more likely to participate in government sponsored collaborations in the future, given its experience with the Società, the mean response on a 7 point scale (1=much less likely, 7=much more likely) was 5.6, also indicating that the Società program was effective in encouraging future relationships.

6. How Do Società Participants View Government’s Role?

The structure of the Società program as discussed above, suggests that the government’s role is much more than simply funding. The government, through IMI, helps to control opportunism via multiple mechanisms. We propose that member firms both perceive and value this additional governmental role. This hypothesis is tested through the survey of 39 firms participating in a Società. The focus of the survey was to understand why firms participated in a government sponsored research consortium rather than simply forming one on their own. Did they view government’s role in the Società as simply providing funds, or were other aspects of government’s involvement also important in influencing their decision to join?

6.1 Measuring Firms’ Perceptions: Determination of Variables

To address this issue, each firm was asked, in the written survey, why it chose to execute joint research projects through a Società as opposed to through an independent research consortium. They were asked to rate the importance of seven different benefits of a Società. These seven benefits were based on our earlier interviews and are defined in Table 2.

--- Insert Table 2 about here ---

The traditional benefit firms expect from a government sponsored consortium, preferential access to funding, is represented by the first variable, Provide Funding. Institutional mechanisms by which the government decreases the ex-ante transaction costs of initiating collaborative research are represented by the variable Establish Framework for Cooperation. Administrative mechanisms by which the government decreases ex-post transaction costs are represented by four variables: Guarantee Project Completion, Avoid Conflicts, Establish Long Term Relations and Facilitate Networking. Finally, Offer Technical Expertise reflects the high level of technical knowledge resident in some of the Società. A firm may join in order to gain access to particular technological experts.

In order to understand the relative importance of these reasons for participation, respondents rated them in two ways: 1) each reason was rated on a 7 point Likert scale ranging from 1="not important" to 7="very important" in influencing the firm's decision to perform a project through a Società rather than through a non-government sponsored consortium. 2) The respondent ordered these same reasons according to their relative importance on an interval scale. Respondents were instructed to write the number of the most important item at the top of the scale, and the number of the least important item at the bottom of the scale. Other items were then placed in between, with the distance between items representing their relative importance. Values between 1 and 8 were assigned to each item depending upon its position on the scale. For instance, if all eight items were equally spaced along the scale, the most important item would be assigned a value of 8, the next most important item assigned a value of 7 and so on. If, on the other hand, four items were clustered at the top of the scale, and four clustered at the bottom, the top four would receive a score of 8 and the bottom four a score of 1.

While our first measure represents the independent ratings of the items, the second measure forces a relative comparison of them. In order to capture both of these dimensions, we added the two ratings together, using the sum as the basis of the analysis.¹⁵ This final rating was rescaled to run from zero to one in order to make comparisons of ratings easier to understand.

¹⁵ The results are not sensitive to which measure is used; doing the analysis using only the first measure or only the second measure yields the same results as using the sum of the two.

6.2 The Relative Importance of Controlling Opportunism as Opposed to Funding

Firms apparently appreciate government's involvement in a research consortium not only for access to funding; aspects of government's institutional role and its administrative role are also valued. In order to see how firms valued these additional roles as opposed to funding, pairwise t-tests were run on the entire sample, comparing the mean of Provide Funding with the mean of each of the other reasons for joining. The results are displayed in Table 3. The means of Guarantee Project Completion, Establish Long Term Relations and Facilitate Networking were not significantly different from the mean of Provide Funding. Hence funding does not emerge as the most important reason for a firm to participate in a Società. This result tends to support the hypothesis that firms recognize and value government's role in controlling opportunism and are not simply looking for funding.

The low ratings of Establish Framework for Cooperation and of Avoid Conflicts relative to Provide Funding, however, are not consistent with these results. By next examining the role of a firm's prior experience in collaborative R&D, we shed some light on this apparent contradiction.

--- Insert Table 3 about here ---

6.3 The Role of Prior Experience

The literature on collaborative ventures as well as the literature on organizational learning¹⁶ indicate that, through experience, firms can develop expertise in forming and carrying out such ventures. Harrigan [26] feels that part of a firm's competency can be expertise in forming joint ventures. Ciborra [13, p.59] also supports this view pointing out "a firm can learn how to set up and fine tune alliances *per se*. The result of such learning is the institutionalization of the organization's rules and routines aimed at managing alliances." Brockhoff [7], using a sample of 135 German firms, observes that prior experience with inter-firm cooperation seems to reduce

¹⁶ A large body of related literature has examined learning and collaboration in terms of a firm's ability to learn from its partners in a collaboration (see Dodgson [18] for a summary). With experience, firms can do a better job of technology transfer. They essentially learn to learn. While not directly related to controlling opportunism, this literature might imply that firms can also learn to better manage opportunistic behavior.

transaction cost problems. Finally, Simonin and Helleloid [52] find that firms do develop “collaborative know-how” through experience in international strategic alliances.

If firms do learn to better manage collaborations, one would expect to find that firms with experience in prior collaborative ventures would place less value on governmental assistance in controlling opportunism than firms without prior experience do. An experienced firm may feel it knows, for instance, how to set up the initial agreement or to make sure projects are completed. An inexperienced firm, on the other hand, should better appreciate the government performing these roles. This leads us to our first hypothesis:

H1: Firms with prior experience in collaborative R&D will place less value on governmental help in decreasing transaction costs than firms without any prior experience.

An alternative hypothesis, however, is that firms with prior experience in collaborative R&D have first hand knowledge of the difficulties encountered in organizing and operating such a collaboration. The observation that most cooperative endeavors do not succeed in the long run [32, 33] could suggest that firms tend to underestimate the difficulties involved with inter-firm cooperation. Consequently, firms that have experienced the challenges involved in cooperation might place more value on government assistance than firms without prior experience. Firms with prior experience have a basis for comparison and may better appreciate the role performed by the government. This rationale leads to a second, alternative hypothesis:

H2: Firms with prior experience in collaborative R&D will place more value on governmental help in decreasing transaction costs than firms without any prior experience.

To test these hypotheses, firms were grouped into those that have participated in prior research collaborations (labeled “with prior experience”) and those for whom the Società was their first collaborative experience (labeled “without prior experience.”) The results of comparing these two groups are presented in Table 4. Two types of analysis were performed: 1)

Comparing relative importance: This analysis is an extension of the analysis performed for the whole population. Within each group, the mean of Provide Funding is compared to the mean of each other variable using a t statistic. 2) Comparing absolute importance: The mean of each variable for firms with prior experience is compared to the mean for firms without prior experience using a t statistic.

--- Insert Table 4 about here ---

6.3.1 *Comparing Relative Importance*

In comparing firms with and without prior experience, we find that the validity of our two hypotheses depends upon whether we consider government's institutional mechanisms or administrative mechanisms. When examining the importance of institutional mechanisms relative to funding, we find support for the first hypothesis. For firms with prior experience in joint research, the mean importance of Establish Framework for Cooperation is lower than the importance of Provide Funding. For firms with no prior experience, however, there is no significant difference between the two means. This result supports the notion that firms feel they can learn to set up collaborations on their own and don't need the government to establish a framework for them once they have experience.

If we examine Administrative mechanisms, however, we find support for our second, alternative hypothesis. For firms with prior experience in collaborative R&D, on average, administrative mechanisms were as important as funding in driving a firm's decision to join a Società. Avoid Conflicts, which was rated as significantly lower than Provide Funding for the overall sample, was not significantly lower for the subset of firms with experience. For firms with no prior experience, however, all of the administrative mechanisms, including Avoid Conflicts were rated as significantly less important than funding. Thus, as far as administrative mechanisms are concerned, firms with prior experience placed more relative value on governmental help in decreasing transactions costs than firms without experience did. Perhaps firms with experience in other consortia are, in fact, better able to appreciate the role the government plays in facilitating ex-post cooperation among partners since they have something to compare the experience to. They appreciate this part of government's contribution as much as they do funding.

6.3.2 *Comparing Absolute Importance*

When comparing the absolute importance of each factor for firms with and without prior experience, we find that the results also depend strongly on whether institutional or administrative mechanisms are investigated. When examining institutional mechanisms, results are consistent with the prior analysis: hypothesis one is supported. Establish Framework for Cooperation is rated lower by firms with prior experience than by those with no prior experience. Again, firms without experience setting up a collaboration value the preset framework most highly since they have less knowledge of how to handle all the details of organizing one. Firms with experience in collaborations have a better sense of the important issues, and perhaps can even use their prior collaborative agreements as a starting point for future agreements. They therefore place less value on the government performing this role.

An examination of administrative mechanisms provides very weak support for the second hypothesis. While not statistically significant, the average rating of administrative mechanisms is higher for firms with prior experience than for firms without, lending some support to the conclusions of the prior analysis.

Finally, we find that firms with prior experience have significantly reduced expectations regarding the importance of receiving governmental funding. The absolute importance of Provide Funding is significantly lower for firms with prior experience in a collaboration than for firms without prior experience.

--- Insert Table 5 about here ---

We therefore see that the validity of Hypothesis 1 and Hypothesis 2 depends upon whether one is discussing institutional or administrative mechanisms employed by the government. Results are summarized in Table 5. For institutional mechanisms such as establishing a framework for cooperation, Hypothesis 1 appears valid. It would seem that firms with experience can, indeed learn how to organize a collaboration up front, and place less value on the government performing that role. For administrative mechanisms aimed at controlling ex-post opportunistic behavior, however, Hypothesis 2 appears more valid. Firms with prior experience appreciate how

difficult it is to manage a collaboration ex-post, and place more value on governmental assistance. Administrative mechanisms aimed at controlling ex-post opportunism may therefore be more important and should, perhaps, receive more emphasis from policy-makers.¹⁷

7. Conclusion

In light of the large number of firms participating in collaborative research projects, defining an appropriate role for government in such projects is a salient issue for policy-makers. While traditionally, discussion has focused on determining a suitable level of government funding for collaborative R&D, the purpose of this paper was to articulate an additional role for the government, one of facilitating collaborative R&D through overcoming opportunistic behavior. Using a transaction cost framework we have shown how the government, through institutional and administrative mechanisms, can help to decrease both the ex-ante and ex-post transaction costs associated with collaborative R&D. By providing an up-front framework and then helping to monitor and enforce agreements, the government fosters cooperation among firms. This role was evident in the organization and operation of the Italian government-sponsored Società di Ricerca program. Through a survey of firms participating in a Società, we

¹⁷ There are many possible alternative explanations for the difference found between firms with and without prior experience. We have ruled out as many of these rival hypotheses as possible, and summarize those results here:

- 1.) Firm Size: When the sample is split into large and small firms, based on 1990 sales, all of the firms that have not participated in other joint research are classified as "small." To ensure that experience was not simply a proxy for firm size, the analysis was repeated using only the population of small firms; the same pattern of differences between firms with and without prior experience was found. Firm size is therefore not responsible for the results.
- 2.) Type of Società, Coordinating or Operating: All of the firms without prior experience are members of Coordinating Società. To ensure that experience was not simply a proxy for Società type, the analysis was repeated using only the population of firms belonging to Coordinating Società; the same pattern of differences between firms with and without prior experience was found. The type of Società is therefore not responsible for the results.
- 3.) Firm tenure with the Società : There is no statistically significant difference between the tenure of firms with prior experience vs. those without. There is also no statistically significant difference between the number of projects completed within the Società. Tenure is therefore not responsible for the results.
- 4.) Firm geography, north vs. south: There is not a substantial difference in the composition of the firms with and without experience, in terms of geographic dispersion. Firm geography is therefore not responsible for the result.
- 5.) Società Industry: When the sample is split by Società, there is no significant difference between the ratings of the reasons for participation. Società industry is therefore not responsible for the result.

were able to confirm that firms recognize and value government performance of this role. Our specific findings are summarized as follows:

- For the overall population, firms rated government's role in guaranteeing project completion, establishing long term relationships, and facilitating networking just as highly as providing funding in driving their decision to perform research through a Società.
- Firms with prior experience in joint research learn how to organize the collaboration ex-ante. They placed significantly less value on government's institutional role in establishing a framework for cooperation than firms with no prior experience did.
- Firm's with prior experience in joint research do not learn, however, to control ex-post opportunism. Instead, they become more cognizant of government performing that role. They rated administrative mechanisms aimed at ex-post transaction costs at least as important as funding in their decision to perform research through a Società. In contrast, firms without prior experience rated funding as significantly more important an influence than administrative mechanisms.

These results raise several important questions regarding government's involvement in collaborative research. First, this research suggests that government can play an important role as a quasi neutral third party. Government, however, often has its own agenda. It may voice opinions about the content of the collaboration, favoring specific approaches and solutions. Thus, under some circumstances it might not be able to fulfill this role. In the case of the Italian Società di Ricerca, government appears to be relatively neutral. It is interested in the success of these Società but not in specific content issues.

Furthermore, it is perceivable that government may favor some actors, for example, large firms with which it frequently interacts, over others. Consequently, small firms might no longer perceive government as a neutral actor — they actually might oppose a government involvement because it could shift the balance of power even more to the large firms. As suggested by Brockhoff [8], this perception is held by several small technology intensive firms in Germany. Again, this does not appear to be the case with the Società di Ricerca. Based on our interviews with small firms we found no similar sentiment. One of the goals of the program is, in fact, to encourage technology transfer to smaller firms. Perhaps with this in mind, the government is more careful about ensuring equitable treatment.

Finally, there is the issue of the cost of having the government involved. Government programs have a way of growing, creating large self-perpetuating bureaucracies. In the case of the Società program, however, the overhead appears to be minimal. The existing administrative structure of IMI was used with the addition of a few employees devoted exclusively to the Società program. In fact, relative to outright funding of technology development, sponsoring collaborations may be viewed as an inexpensive way to leverage private resources.

While government funding is still an important issue, these results imply that government may want to increase its emphasis on supporting cooperation by helping to control opportunism, especially ex-post monitoring and enforcement. Through explicitly acknowledging the importance of this role and directly exploring ways to best perform it, the government can more effectively encourage cooperation. Additional research, for instance, on how to best structure a collaboration that incorporates an independent party promises to provide useful insights.

The government may not be the only player able to play this role. Other third parties, for instance, industry associations or independent research institutions like universities, may be in a position to help set up, monitor or enforce agreements among firms. While government has some inherent advantages in fulfilling the institutional role of supporting interfirm cooperation, other institutions might be in a better position to fulfill the administrative role due to specific knowledge advantages. As shown in this paper, both might contribute significantly to the success of collaborative R&D.

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Table 1 - Overview of the Società

Società	Overview			Projects			Results ^a		
	Year Established	N° of Partners	N° of Projects Completed	N° of Projects under Development	Average N° of Projects per Partner	Average N° of Partners per Project ^b	Patents	Marketable Product	To be further developed by Partner/ Società
Tecnomare	1971	10	21	7	8.1	2.7	17	4	8
Off-Shore									
Engineering									
SAGO - Health Management	1971	6	14	n/a	5.8	2.5	n/a	n/a	n/a
Tecnotessile	1972	24	7	3	.5	1.4	2	8	1
Textiles									
Tecnofarmaci	1974	18	13	n/a	n/a	1.7	11	0	12
Pharmaceuticals									
Tecnobiomedica	1982	11	17	15	2.5	2.0	n/a	17	17
Medical Instruments									
Tecnoalimenti	1982	18	17	10	1.1	1.8	3	6	11
Food									
Tecnoidrometeo	1986	10	2	5	1.5	2.1	0	0	1
Engineering									
Tecnogen	1987	7	0	4	1.6	6.5	0	0	4
Biotechnology									
Total		104	91	44	-	-	33	35	54
Average		13	11	7	3.0	2.6	5	6	8

^a The results of the projects are split into three categories based on classification scheme recently proposed for all the projects performed under the Fondo Ricerca Applicata [8]. No analysis of project level financial returns are available given the lack of historical project-level financial records.

^b Sometimes a firm will sponsor a project on its own and utilize the Società to identify relevant university research partners as well as provide project management. For this reason, some of the Società show an average of less than 2 partners per project.

Table 2 - Potential Benefits Provided by a Società

Variable	Definition
Provide Funding	Membership in the Società improves access to government funding ^a
Institutional Mechanisms to Decrease Ex-ante Transaction Costs	
Establish Framework for Cooperation	The Società predelineates items such as share ownership and distribution of research results.
Administrative Mechanisms to Decrease Ex-post Transaction Costs	
Guarantee Project Completion	The Società helps guarantee that the other partners will complete their part of the project
Avoid Conflicts	The Società will help to avoid potential conflicts with the partners.
Establish Long Term Relations	The Società helps firms to establish long term relationships with the partners.
Facilitate Networking	The Società provides a network through which firms can find the best suited project partner.
Benefit Not Related to Transaction Costs	
Offer Technical Expertise	Employees of the Società have technical expertise which members can access

^a Provide Funding combines two original variables: the first addressed the overall increased likelihood of receiving government funding as a member of a Società. The second addressed the help provided by the Società in the complicated process of applying for government funding of joint projects. In our interviews, firms made clear that assistance with the application significantly increased the odds of receiving funding. The two were therefore treated as one construct representing improved access to government funding.

Table 3			
Some Transaction Cost Reasons for Participation Are as Important as Funding			
Pairwise t-test comparing the mean of "Provide Funding" with other variable means n=39			
	Mean	Std. Deviation	
Provide Funding	.55	.15	
Institutional Mechanisms			
Establish Framework for Cooperation	.42**	.19	
Administrative Mechanisms			
Guarantee Project Completion	.47	.11	
Avoid Conflicts	.38**	.08	
Establish Long Term Relations	.46	.15	
Facilitate Networking	.46	.15	
Additional Benefits			
Offer Technical Expertise	.51	.15	

* p < .10, ** p<.05 in comparison of Provide Funding with other variable means

Table 4

Firms with Prior Experience
1) Learn to Control Ex-ante Transaction Costs and Place Less Value on
Institutional Mechanisms
2) Value Administrative Mechanisms as Highly as Funding

Pairwise t-test comparing the mean of "Provide Funding" with other variable means
for firms without prior experience in joint R&D and
firms with prior experience in joint R&D

Pairwise t-test across categories, comparing the mean of each variable for
firms without prior experience in joint R&D vs.
firms with prior experience in joint R&D

	Firms without prior experience n=8	Firms with prior experience n=29	t-test across categories: p-level
Provide Funding	.77	.48	p < .05
Institutional Mechanisms			
Establish Framework for Cooperation	.58	.35*	p < .10
Administrative Mechanisms			
Guarantee Project Completion	.42**	.47	ns
Avoid Conflicts	.30***	.40	ns
Establish Long Term Relations	.37**	.49	ns
Facilitate Networking	.44***	.46	ns
Additional Benefit			
Offer Technical Expertise	.55*	.51	ns

* p < .10, ** p < .05, *** p < .01 in comparison of Provide Funding mean with other variable means

Table 5
 Summary of Data Analysis
 Effect of Prior Experience in Collaborative R&D on Valuation of Government

Type of Analysis	Governmental Institutional Mechanisms	Governmental Administrative Mechanisms
Comparison of governmental mechanisms relative to funding	Hypothesis One supported	Hypothesis Two supported
Comparison of absolute importance of government mechanisms for firms with and without prior experience	Hypothesis One supported	No significant difference between firms with and without prior experience

Figure 1
Tecnobiomedica Shares Distribution

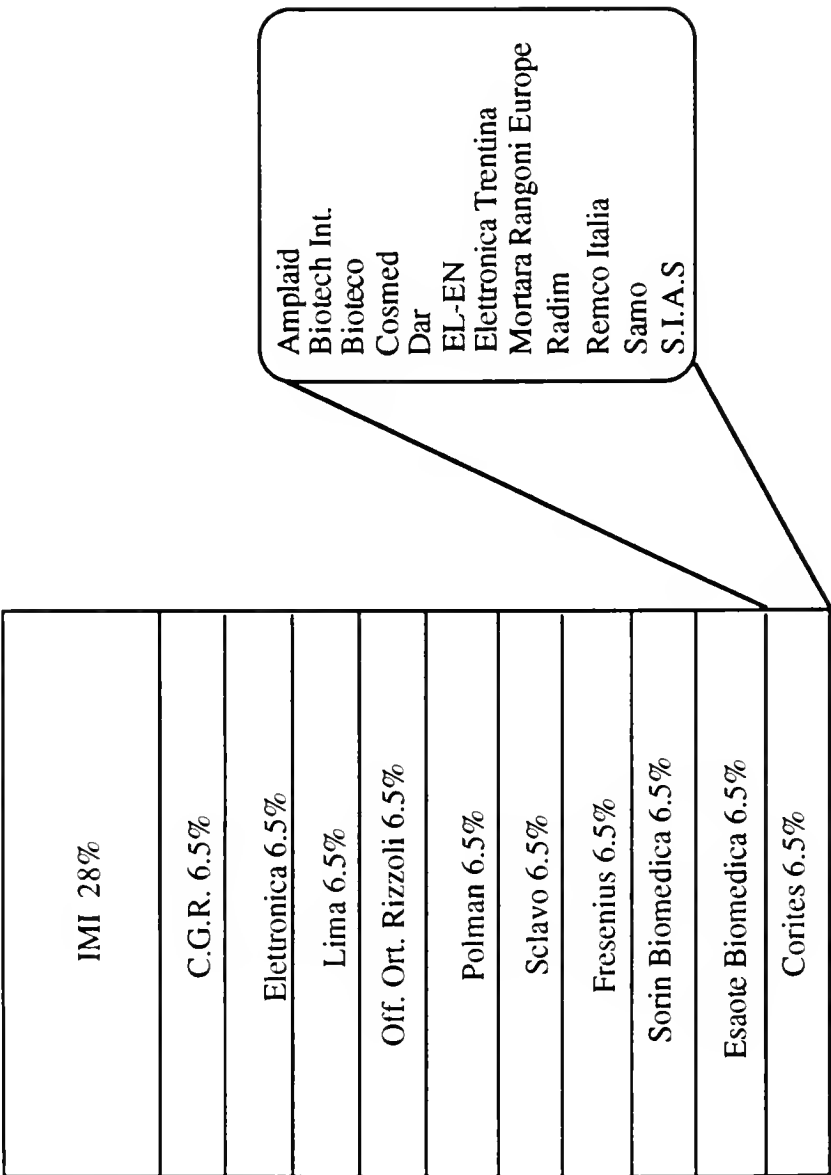
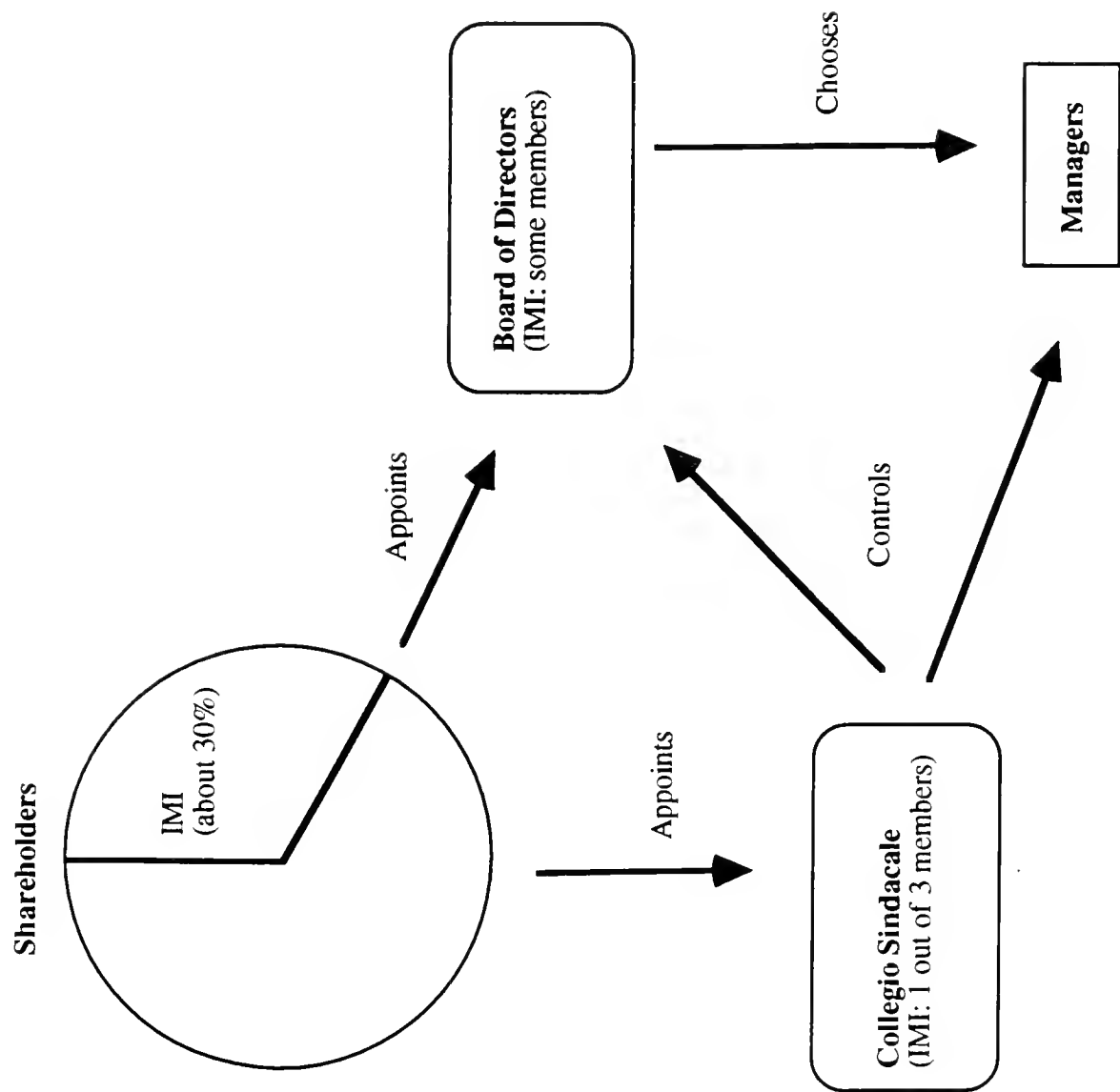


Figure 2: IMI's Role in Società Governance



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